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ABSTRACT

A simulated art history textbook reading assignment was designed to examine the effects of visual information on student learning and understanding. A sample of 234 students was taken from a population of freshman/sophomore English students in a large metropolitan community college district. In phase one of the study, students took the Group Embedded Figures Test (GEFT), which contained geometric figures embedded in a background. During phase two, students were randomly assigned to one of two different groups in which the treatments were two 1500-word expository prose passages. The difference between the two treatments was in the number of pictures; although the picture subject matter was identical, one treatment included additional close-up photographs and illustrations. Students were asked to visualize the pictures of vases that they had read about, then to draw each vase and write down every word recalled from the reading. Results suggest that when subjects are asked to recall pictures of single objects, most subjects can successfully execute in drawings a reasonable likeness of what they have seen and that subjects' performance is differentially reflected on the basis of both cognitive style and picture design factors. Eight figures depict study results. (Contains 27 references.) (AEF)

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Eyes On Cognitive Styles And The Processing Of Visual Information

ED 391 509

by Robert Sitz

Introduction

The specific manner in which an individual functions during the perceptual process of gathering and handling visual information from the environment has a long tradition of inquiry pertinent to several academic disciplines. One area of visual information processing, cognitive response to pictures, reveals an emerging body of scientific literature nourished by scholars in Psychology, Educational Technology, Art Education, Consumer Behavior, Graphic Design, and Mass Communications. There are probably others! "Eyes on the future" should see a greater convergence of ideas, issues and research brought to bear on fundamental topics such as "what do people learn from pictures?" as professionals continue to talk to each other at these conferences.

One visual communication format worthy of discussion, yet taken for granted, are the textbooks used by students at all levels of formal education. Today, textbooks embrace a wide variety of design styles and techniques. Graphics, pictures, and illustrations proliferate the prose content of textbooks in most subject areas. Yet there appears to be little consensus regarding the mediating effects of all of these visuals on student learning and understanding.

Literature Review

A review by Levie and Lentz in 1982 summarized a number of studies that demonstrated the positive effects that illustrations have on reading text. But they also described a number of cases where there were opposing effects, or no effects at all (Hurt, 1987). It has been hypothesized by a number of scholars that picture effects depend on such learner characteristics as age, sex, and intellectual ability (Levin and Lesgold, 1978). Even with the most well-designed visual communication, it apparently cannot be presumed that the readers' attention will be given to the illustration or the photograph (Hayes and Readance, 1983; Rosco, Tennyson and Boutwell, 1975), and if it can be determined that the reader has attended to the visual, it does not necessarily follow that interaction between the reader and the picture has been sufficient to cue the learner's attention to the most critical information (e.g., Allen, 1978; Dwyer, 1978; Gagne and Rohwer, 1969)

In an extensive series of experiments over the years, Dwyer has varied levels of detail realism in instructional illustrations of the heart to determine if the stimuli characteristics had differential effects on the achievement level of students. Despite these task appropriate illustrations, it does not

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appear that students experience comparable degrees of picture facilitation. If pictures are going to be effective, they must activate certain information processing skills within the learner. If the learner does not process those skills, poor results will be achieved (Levin; cited in Pressley and Levin, 1983). Evidence suggests that learners will frequently overlook detail in complex illustrations unless they are prompted to pay attention (Beck, 1984), and some individuals may benefit from systematically detailed visuals designed to further isolate important content (Goldsmith, 1984).

Once the picture is integrated with words, passages, or continuous text, the effects of pictures on the individual become confounded. For example, an experiment using one sentence propositions with simple line drawings may yield results different from those studies using line drawings with complex prose. Rusted (1984) has suggested that factual expository prose passages have produced a different pattern of results than have narrative passages. In sum, most scholars agree that pictures are "complex, multivariate media" (Hurt, 1987) and they perform different functions in different circumstances (Duchastel, 1978). Complicating the effect of pictures is the learner!

The Problem

Among the many objectives of education is the cultivation of those perceptual and cognitive skills that enhance the students' ability to critically examine visual information. A related individual difference in perception and learning/memory that has a solid grounding in research is the bi-polar trait of Field Independence-Field Dependence that is an outgrowth of Cognitive Style Theory.

The term "cognitive style" was originally coined by Allport in 1937 but greatly refined by Asch and Witkin. Witkin and his associates eventually broadened the idea to include "analytical-global" functions and "psychological differentiation." Today "cognitive styles" are seen as individual "information processing habits representing the learner's typical mode of perceiving, thinking, problem solving and remembering." (Messick, 1976). Field Independence versus Field Dependence has possibly been the subject of more research than any other Cognitive Style dimension (Keefe, 1987).

It has been hypothesized that Field-Independent people (FI's) are better able to separate information from an overall visual context, whereas Field-Dependents (FD's) respond more holistically to the stimuli context as given, without using mediational processes such as analysis and structuring. Compared to FI's, FD's are more dependent on external sources of structure and organization.

It is also suggested that when recalling information, the thought strategies of the two cognitive style types will vary greatly. The Field-Dependent person will remember the most noticeable cues and information recall will be hindered if the relevant visual cues are not obvious. Field-Independents are able to identify the most important visual cues whether or not they are made salient (Wilkin, et al., 1977; cited by Moore, 1985).

The implication is that increased stimulus structure at the time of information acquisition could help the Field-Dependent learner, whereas the Field-Independent learner would not be as dependent on manipulations that cue information organization.

There are a variety of design techniques that can help the student assess the priority (or importance) of diverse information elements within both text and pictures. For example, the text may cue the reader to attend to a particular picture. However, as suggested previously, just because the student notes the picture, it doesn't necessarily mean that the student will process the appropriate information contained within the picture. Research has

demonstrated that picture cueing devices produce inconsistent findings in regard to the learner's ability to store and remember pictorial information (Beck, 1984; 1987).

Purpose of the Study

Given the Field Dependent student's more global approach to processing information, and apparent reluctance to use mediational processes such as analysis and structuring, it was hypothesized that certain pictorial information cues would most likely be ignored and that learning would be improved if detail was made more salient. For example, in an Art History textbook, a great deal of descriptive information is condensed into a compendium of historical background. The expository prose includes references to pictures that invite serious analysis and organization of visual detail. An Art History textbook presents an intriguing scenario for studying FI/FD predispositions to analyze, encode, and remember pictorial information!

The purpose of the study became one of designing a simulated art history textbook reading assignment utilizing a quasi-experimental design to:

1. determine if different picture design treatments have an effect on memory in a comprehensive picture-prose learning context;
2. investigate the effects of detail pictures (close-up pictures) as a design strategy for cueing the reader to encode and process visual information as reflected by their performance on a recall task;
3. compare the Cognitive Style dimensions of Field-Independence and Field-Dependence in regard to analysis and organization of complex picture and prose information that is either cued or not cued by detail pictures.

Research Questions

The answers to the following research questions were sought to clarify the mediational effects of picture design cues on the encoding of visual information detail given individual differences in cognitive style:

Null Hypothesis:

H_1 There is no significant difference in recall between Field-Dependent and Field-Independent cognitive styles.

H_2 There is no significant difference in recall between subjects participating in picture treatment "A" and picture treatment "B."

H_3 There is no significant interaction between Field-Dependent/Field-Independent subjects and picture treatment "A" or picture treatment "B" on a measure of free recall.

Study Design

In the interest of brevity, many of the research design specifics will be eliminated or summarized for purposes of this presentation so that more attention can be focused upon the gist of the study.

A sample size of 234 students was taken from a population of Freshman/Sophomore English students in a large metropolitan community college district.

In phase one of the study, students took the "Group Embedded Figures Test (GEFT)." The GEFT has been modeled after the individually administered Embedded Figure Test (EFT) that suggests a reliability of .82 for both males and females. The GEFT is a booklet that contains geometric figures embedded in a background. Some people have difficulty identifying the figures which must be traced with a pencil. For other people, the task of locating, or "seeing" the simple geometric form that is embedded within the more complex background is easy. Subjects were classified as Field-Independent, Neutral, or Field-Dependent based on their scores on the Group Embedded Figures Test.

Figure 1:
GROUP EMBEDDED FIGURES TEST.

Simple Forms Correctly Outlined	Cognitive Style
0 - 8	Field-Dependent
9 - 13	Neutral
14 - 18	Field-Dependent

During phase two of the study, students were randomly assigned to one of two different treatment groups. The treatments were two 1500-word expository prose passage(s) excerpted from A History of Art (Hartt, 1986). The passages were laid out on 8-1/2 x 11 typing paper and stapled together to create a booklet simulating a textbook reading assignment covering the topics of Greek Vase Painting during the Geometric, Orientalizing, and Archaic style periods of Greek History. The passages selected were descriptive in nature and referenced photographs of the vases pictured in the text. The prose and picture layout resembled the actual textbook pages in appearance.

The difference between the two treatments was in the number of pictures. Although the picture subject matter (a single vase) was identical, one treatment included additional close-up (detail) photographs and illustrations. The "detail" pictures highlighted various decorative and functional features of the Greek vases. The close-study pictures were outline drawings to emphasize the vase shapes and details such as handles; in other instances, the close-study pictures were small illustrations and photographs of ornament and decoration.

Figure 2:
SYNOPTIC PICTURE + DETAIL PICTURES (Treatment A)

Figure 3:
SYNOPTIC PICTURE ONLY
(Treatment B)

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The administration of the study took place in the same classroom settings that the students used throughout the regular academic semester. Students were instructed that they would be given twenty minutes to read and study their simulated art history textbooks (booklets). Following the reading/study exercise, all students were told that they would participate in a paper and pencil recall test (dependent measure).

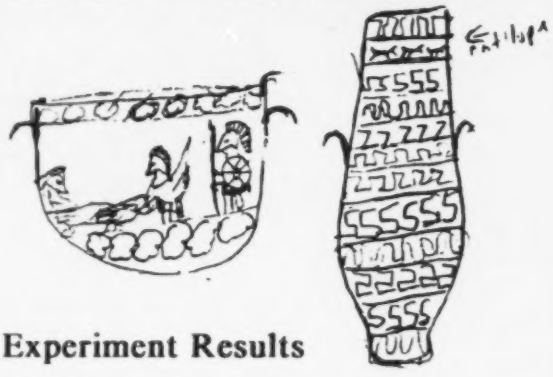
Student/subjects were specifically informed that the test they were about to take is a "test of your ability to recall certain types of visual information." They were asked to visualize the pictures of vases that they had read about, then "to the best of your ability, draw each vase as you remember it. . ." and, as quickly as you can, write down every word and/or fact that you can recall from the reading." Subjects were given twenty minutes to complete the recall test.

The drawing test results were evaluated by an independent, trained graduate student. A ten point criterion measure was provided for the evaluator.

Figure 4:
EVALUATION
CRITERIA/DRAWINGS

Overall Vase Shape	1 point
Handle Location/Depiction	1 point
Foot Detail Depiction	1 point
Neck Shape	1 point
Neck Lip	1 point
Band/Register Depiction	1 point
Internal Figure/Object Depiction	1 point
Ornament Detail	1 point
Relative Vase Sizes	1 point
Organization from Left to Right	1 point
Total per Picture Possible	10 points

Figure 5
EXAMPLES OF DRAWING RESULTS



Experiment Results

The results of the study have been reported in a separate document in four sections in accordance with the statistical procedures used to analyze the data.

In summary, the research hypothesis for this study were tested by an analysis of variance based on a 2 x 2 factorial design. Two-way ANOVAs were run on the mean scores for each of three dependent variables:

1. drawings scores;
2. verbal scores;
3. combined or total score.

The scores were the cumulative number of good responses for the paper and pencil free recall drawing measure and free recall verbal measure.

In the first of three two-way ANOVAs to test drawing scores, significant main effect was evident for the Cognitive Style independent variable $F(1, 101) = 15.919$ $p = .0001$. There was also a significant main effect for the independent variable of Picture Design Type, $F(1,101)$ 8.744 $p = .0041$. As can be seen in Figure 5 there was no significant interaction effect between the two independent variables.

In the second of three two-way ANOVAs, the dependent measure was verbal score (Figure 6). The analysis of variance yielded no significant main effects

for either independent variable at the .05 level. However, at a p <.10, a main effect of F(1,101) 3.507 is evident for the Cognitive Style variable. Again, there were no interaction effects between Cognitive Style and Picture Design Type.

Figure 6:
DRAWING SCORES:
ANOVA SUMMARY OF FINDINGS
BETWEEN SUBJECTS

Source	Mean Squares	df	F-Ratio	Prob
Cognitive Style	955.874	1	15.919	.000
Picture Design	525.020	1	8.744	.004
Cognitive Style X				
Picture Design	3.021	1	.050	.807
Within	60.04471	101		

Figure 7:
VERBAL SCORES:
ANOVA SUMMARY OF FINDINGS
BETWEEN SUBJECTS

Source	Mean Squares	df	F-Ratio	Prob.
Cognitive Style	748.368	1	3.507	.061
Picture Design	6.236	1	.029	.841
Cognitive Style X				
Picture Design	187.397	1	.878	.354
Within	213.38921	101		

The final two-way ANOVA was performed on the mean of total scores combined drawing scores and verbal scores). Based on total score, a main effect was found for the Cognitive Style variable only F(1,104) 9.381 <.05. No main effect was found for the Picture Design Type variable, and no interaction effects were determined.

In terms of drawing test scores, the null hypothesis that there is no significant difference in recall between Field-Dependent and Field-Independent cognitive styles was rejected (H_1). Likewise, the null hypothesis that there is no significant difference in recall between subjects participating in picture treatment "A" and picture treatment "B" was rejected (H_2). The null hypothesis that there would be no significant interaction between Picture Design Type and Cognitive Style (H_3) must be accepted.

Verbal score analysis suggests a different profile. Both null hypothesis (H_1) regarding cognitive style and null hypothesis (H_2) that there is no significant difference in recall between subjects participating in picture treatment "A" and picture treatment "B" were accepted. Similarly, the study fails to reject the null hypothesis that there is no significant interaction between Cognitive Style and Picture Design Type (H_3).

Figure 8 outlines mean scores and standard deviations for the three dependent variables. One-way analysis of variance was run to contrast the various cells. In regard to the free recall drawing exercise, significant differences were found between each cell causing the previously discussed main effects.

The data verifies significant differences between the Field-Independent and Field-Dependent Cognitive Styles in regard to both picture treatments.

Comparison of verbal scores yields only one difference and that is within the synoptic picture-only treatment. FI scores are

significantly higher.

Figure 8:
MEANS AND STANDARD DEVIATIONS
FOR TWO RECALL MEASURES.

Cell	Criterion Measure		
Independent Variables	Drawing Recall	Verbal Recall	Total
(Cell 1)			
Field Dependent	Mean =		
	16.6452	20.0645	36.7097
Synoptic Picture	S.D. =		
+	7.9396	15.9967	19.0900
Close Study	N 31	31	31
(Cell 2)			
Field-Dependent	Mean =		
	20.8214	17.8571	38.6786
Synoptic Picture	S.D. =		
+	7.9396	10.0645	15.4100
Close Study	N 28	28	28
(Cell 3)			
Field-Dependent	Mean =		
	22.4000	22.7600	45.1600
Synoptic Picture	S.D. =		
-	7.5194	17.6376	22.7050
Close Study	N 25	25	25
(Cell 4)			
Field-Dependent	Mean =		
	27.2524	25.9524	53.2143
Synoptic Picture	S.D. =		
-	7.4223	13.5544	18.4997
Close Study	N 21	21	21

Conclusions

The results of this experiment clearly suggest that when subjects are asked to recall pictures of single objects such as the photographs of the Greek vases, most subjects can successfully execute in drawings a reasonable likeness of what they have seen. It is also apparent that subjects' performance is differentially reflected on the basis of both cognitive style and picture design factors.

Field Independent subjects demonstrated, based on their results on the drawing recall test, that they remembered a greater number of the pictured Greek vases than Field Dependent subjects. The Field Independent subjects also exhibited superior articulation of the pictured vase detail.

In terms of picture design, there was a distinct difference in performance between subjects in one treatment versus the other. Design does make a difference, but not in the direction that intuitive logic and the theoretic assumptions would have expected! Those students that received the experimental treatment that incorporated close-up photographs, outline drawings, and illustrations in addition to the synoptic pictures performed more poorly. In other words, additional pictures that made pictorial detail more salient did not enhance recall for either Field Independent or Field Dependent students.

When verbal scores are used to evaluate subject reading/study performance, the results are less definitive than the results obtained on the drawing criterion measure. In general, Field-Independent subjects again outperformed Field-Dependent subjects on the free recall verbal measure under both picture design treatment conditions.

Discussion

The finding that there is a distinct difference in performance between Field-Dependent and Field-Independent cognitive style subjects on the free recall measures that were the focus of this study is intriguing. Contrary to the idea posited by some scholars that there will be no difference in memory performance, this study's data suggests the opposite.

Although the design of the study did not accommodate an analysis of the encoding and retrieval processes postulated to be different between Field-Independents and

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Field-Dependents (Goodenough, 1976), the evidence reveals differences in sheer memory output. Field-Independent subjects did achieve higher scores on both drawing and verbal tests. It can only be inferred that different information processing styles were invoked by the two cognitive style groups.

Whether the superior FI performance is the result of a more analytic, focused attention style discussed by Schmeck (1988), or an ability to impose organizational structure as suggested, is open to conjecture. The idea that Field-Independent people are more likely to impose structure on stimulus material that lacks structure would seem to have a great deal of relevance to the Art History reading/study situation. Why the close-study pictures failed to facilitate organization and structuring, as indicated by the inferior recall scores of both Field-Independents and Field-Dependents in the close-study treatment condition, is difficult to answer. However, the answer might be found in the idea of the picture as a "mediator."

Field-Independents are hypothesized to be able to make better use of mediators, and/or use mediators of their own design. In concept attainment situations, for example, the more salient cues are reportedly generally easier to learn than the less salient cues. Fleming (1968) was able to show that the Field-Dependent subject recalled fewer words than the Field-Independent subjects when the inherent hierarchial organization structure of superordinate to subordinate words was reversed. Thus, the most salient organizational cues confounded the normal learning structure, and required the subject(s) to create their own mediational devices in order to retrieve the information. The Field-Independent, it has been suggested, will be much more successful at the use of existing mediators or a design of their own. When the organization of information is already inherently highly structured, it is possible that the invocation of mediational factors becomes unnecessary. This was born out in Fleming's study when there was no significant difference shown in word recall between the Field-Dependent and Field-Independent subjects when lists were highly structured from superordinate to subordinate sequences (Witkin et al., 1977; cited by Moore, 1985). There appears to be the possibility of a parallel to those findings in this Art History reading/study experiment.

When this study was designed to accommodate the constraints of a more naturalistic experiment, the "simulated" Art History text was modified. Verbal information that is characteristically diverse in its content was adjusted to reflect descriptive information only. The expository prose quite directly described the pictured subject matter, the Greek Vases. Coupled with the concretization potentials of representational photographs, the entire prose-picture scenario may have become less abstract and conceptually ambiguous. This may have negated the need for either design imposed or self-imposed mediators, because the most salient cues were already so obvious and highly organized.

One of the contentions of the study was that while the FI subject is more capable of making use of mediators, the Field-Dependent subject would benefit the most from mediators provided by the text, graphic design variables, or pictorial cues. This effect was not evident and, in fact, the imposition of close-study pictures appeared to do just the opposite. Although the study design does not enable appropriate insight, the data suggest that close-study pictures either did not provide any facilitative effect, or they may have been deleterious to the processing of visual information.

It was believed that semantic and pragmatic emphasis factors, along with certain text parallels (Goldsmith, 1984), could be enhanced through specific design treatments. In other words, the graphic artist or instructional designer should be able to easily effect the importance of certain types of information through the use of cueing devices. A variety of "principles" from cue summation (i.e., Salomon, 1972) to the amount of visual detail provided (i.e., Nelson, Metzler & Reed, 1974) have been presented to support the "intuitive logic" of supplementing synoptic pictures with close-study pictures. Outline drawings, in particular, have been shown to be easily recalled (i.e., Ritchey, 1982) and invaluable in the emphasis of criterion exemplars as they pertain to the learning of concepts (i.e., Medin & Smith, 1984).

The results of this study contradicted many of the assumptions concerning the cue enhancing and mediational effects of pictures. Given the complete lack of facilitative effect for either Field-Dependent or Field-Independent subjects when close-study pictures were used to supplement the synoptic picture, the inclination must be to agree with the statement that memory for pictorial detail is not "invariant across all research circumstances" (Dorso & Johnson, 1980).

Summary

It is conceivable that the inclusion of detail picture cues in the form of outline drawings, illustrations, and close-up photographs simply provided unnecessary redundancy to the already obvious. Relatively straightforward photographs of the Greek vases that included the full potential of two-dimensional photographic context may have been adequate to even the most uncultivated eye. Navon (1977) postulated that the most global features are apprehended first when viewing the object; thus, it may have been most elemental to perceive of the shape of a pictured vase, recall its individual nuances, and render a simple outline drawing. Cursory analysis of the subject drawings were intriguing in this sense. The quality of the pictorial information conveyed was good. Skill, or a lack thereof, did not seem to be a problem in translating the memory vision to paper. It is apparent that the outline drawings to emphasize shape were either inappropriate cueing devices or unnecessary to the encoding and retrieval process.

Because of the degree to which the performance of subject mean drawing scores were lower in the close-study picture situation, it would appear that the interjection of additional pictures may have also provided "clutter" that interfered with visual information processing. The outline drawings that were intended to emphasize this dimension of the vases may have added superfluous detail, thereby impeding rather than facilitating increased learning (i.e., Dwyer, 1978). One could speculate that the selective attention capacity of the individual may have reached capacity (i.e., Norman & Bobraw, 1978), or that the subject had difficulty establishing time-sharing priorities relative to the amount of analysis that was required of the more numerous stimuli (i.e., Broadbent, 1971).

At the other extreme, the close-study pictures may have been taken for granted, and not attended to as an important and integral part of the reading/study exercise. The outline drawings and close-up photographs simply may have been "scanned superficially and processed at a very shallow level" (Levie & Lentz, 1982). It is possible that the "complexity" of the "untreated" pictorial subject matter was over estimated

and that the learner really did not need direction in regard to attending to the critical attributes of the artwork photographs. Vase shape, for example, may be quickly and relatively easily processed perceptually.

The success of the study was its elucidation of individual differences in memory performance on the basis of cognitive style and its validation of the significance of design strategies relative to visual information processing. It is apparent that the nature of the criterion measure, in this case free recall drawing scores, has an important bearing on the direction that study results will take.

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